CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY -DECK OFFICER

STCW 78 as amended CHIEF MATE/MASTER REG. II/2 (UNLIMITED)

032-74 - STABILITY AND STRUCTURE

FRIDAY, 24 MARCH 2023

0915 - 1145 hrs

Materials to be supplied by examination centres

Candidate's examination workbook Stability Data Booklet A Stability Formulae Datasheet (Version: September 2020) Graph Paper

Examination Paper Inserts

Notes for the guidance of candidates:

1. Examinations administered by the SQA on behalf of the Maritime & Coastguard Agency.
2. Candidates should note that 200 marks are allocated to this paper. To pass candidates must achieve 120 marks.
3. Non-programmable calculators may be used.
4. All formulae used must be stated and the method of working and all intermediate steps must be made clear in the answer.

Maritime & Coastguard Agency

SQA

STABILITY AND STRUCTURE

Attempt ALL questions

Marks for each question are shown in brackets

1. A vessel is floating upright and is to load TWO weights using the vessel's crane.

   The maximum allowable list is 4 degrees.

   Initial draughts: 6.100 m, forward and aft, in dock water (RD 1.014).

   Crane head 22.50 m above the keel.

   There are TWO weights, EACH 42 t, on the quay 17.50 m from the vessel's centreline.

   Stowage position on deck, Kg 11.90 m, 5.00 m either side of the vessel's centreline. The inboard weight is to be loaded first.

   Using *Stability Data Booklet A*, calculate the minimum initial GM required. (44)

2. A vessel is in ballast and has to transit below a bridge in order to get to the load port.

   A minimum clearance of 2.00 m under the bridge is required and the underside of which is 19.60 m above the waterline at low water.

   Present draughts in dock water (R.D. 1.020): Forward 6.500 m Aft 7.300 m.

   The fore mast is 120 m forward of aft perpendicular (foap) and extends 24.00 m above the keel.

   The aft mast is 19.00 m foap and extends 26.10 m above the keel.

   Using *Stability Data Booklet A*, calculate EACH of the following:

   (a) the final draughts forward and aft in order to pass under the road bridge with the minimum clearance at low water; (16)

   (b) the maximum weight of ballast to load in order to pass under the bridge with minimum clearance. (30)

   Note: Assume masts are perpendicular to the waterline throughout

3. In the event that a vessel with an empty compartment is bilged:

   (a) State, giving reasons, the possible effects (if any) on EACH of the following:

   KG, KB, BM, KM and GM of the vessel in the event of bilging such a compartment below a watertight flat (which is below the waterline). (20)

   (b) List THREE possible actions that may be taken by Ships' staff to reduce these effects and/or minimise these or subsequent losses outlining why EACH action may be useful. (18)

4. (a) Sketch a labelled curve of statical stability for EACH of the following conditions:

   (i) angle of loll condition due to a small negative GMi; (6)

   (ii) list due to an off-centre weight; (8)

   (iii) combined effect of a small negative GMi and an excess of listing moments to one side. (8)

   (b) An unstable vessel lying to an angle of loll to port has an empty double bottom tank subdivided into three watertight compartments (port, centre, starboard) of equal width. The tank must be ballasted to return the vessel to a safe condition.

   Describe the sequence of actions that should be taken and the possible effects throughout EACH stage. (16)

5. Stability instruments should present relevant parameters (fields) of EACH loading condition in order to assist the Master in their judgment on whether the ship is loaded within the approved limits.

   (a) List SEVEN parameters (fields) which should be presented for any loading condition. (14)

   (b) Identify and explain any TWO factors that may influence the accuracy of stability calculations of a vessel (xclude changes to lightship condition). (10)

   (c) Outline FIVE possible reasons as to why a vessel's lightship displacement and KG will change over a period of time. (10)

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032-74 – STABILITY AND STRUCTURE

FRIDAY, 07 JULY 2023

0915 - 1145 hrs

Materials to be supplied by examination centres

Candidate's examination workbook Stability Data Booklet A Stability Formulae Datasheet (Version: September 2020)

Examination Paper Inserts

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Maritime & Coastguard Agency

SQA

STABILITY AND STRUCTURE

Attempt ALL questions

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1. A vessel is floating in saltwater with an initial 4º list to port, an even keel draught of 6.100 m and a KG of 7.90 m.

   846 t of HFO (RD 0.81) is to be loaded into two initially empty double bottom rectangular bunker tanks. The tanks are positioned port and starboard of the centreline with EACH being 18.00 m long and 9.00 m wide.

   Using only the *Hydrostatic particulars* contained within *Stability Data Booklet A* calculate the resultant list of the vessel after partially filling these bunker tanks with equal quantities of fuel. (40)

2. A vessel is floating at draughts 4.800 m forward and 6.400 m aft in salt water and has to dry dock after losing her rudder. Initial KG 8.26 m

   (a) Using *Stability Data Booklet A* calculate the GM at the critical instant; (26)

   (b) Whilst in dock, the rudder is fitted at the aft perpendicular.

   Without benefit of any calculations, state, with supporting reasons, the impact this repair may have on the GM at the Critical Instant. (14)

3. (a) A vessel loads a packaged timber cargo on deck such that there is an increase in the vessel's KG and an effective increase in freeboard (Assume displacement remains constant).

   Sketch the vessel's GZ curve showing the effect of loading this cargo. (20)

   (b) Sketch, on a single set of axes, how the GZ curve for a vessel with a zero GMi is affected by EACH of the following:

   - a rise in the vessel's KG;
   - a reduction in the vessel's KG. (20)

4. With reference to the current International Convention on Load Lines:

(a) define Type A vessels and Type B vessels; (5)

(b) outline the reasons why the following principal characteristics of Type A vessels and Type B vessels results in them having different tabular freeboards;

(i) watertight integrity of the freeboard deck; (5)

(ii) permeability of cargo compartments when fully loaded; (5)

(iii) subdivision of compartments. (5)

(c) state, giving reasons, whether the freeboard will be increased or decreased for EACH of the following circumstances or corrections considered during the calculation of assigned seasonal freeboards:

(i) vessels having LBP 100 m or less; (4)

(ii) block coefficient; (4)

(iii) depth; (4)

(iv) position of Deck Line; (4)

(v) sheer. (4)

5. (a) The current International Convention on Load Lines require the master to be provided with stability particulars for various pre-worked conditions.

Detail the information to be provided for a given service condition, describing how this information may be presented. (24)

(b) A vessel has the following particulars:

KG 7.98 m KM 8.16 m TMD = 8.480 m;

Turning circle diameter 480 m Speed 8.7 knots.

Calculate the angle of heel when turning to starboard. (16)

Note: Assume 1 nautical mile = 1852 m, and g = 9.81 m/s^2

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STCW 78 as amended CHIEF MATE/MASTER REG. II/2 (UNLIMITED)

032-74 - STABILITY AND STRUCTURE

FRIDAY, 06 OCTOBER 2023

0915 - 1145 hrs

Materials to be supplied by examination centres

Candidate's examination workbook Stability Formulae Datasheet (Version: September 2020) Stability Data Booklet A

Examination Paper Inserts

Worksheet Q1 - Trim & Stability Worksheet

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Maritime & Coastguard Agency

SQA

STABILITY AND STRUCTURE

Attempt ALL questions.

Marks for each question are shown in brackets

1. Worksheet Q1 *Trim and Stability* provides data relevant to a particular condition of loading in a vessel floating in dock water of relative density 1.020.

   Stability Data Booklet A provides the necessary data for the vessel.

   By completion of Worksheet Q1 and showing any additional calculations in the answer book, calculate EACH of the following:

   (a) the effective metacentric height; (16)

   (b) the expected draughts forward and aft. (24)

2. A vessel, initially upright, is to carry out an inclining test.

   Present displacement 14 081 t and KM 28.54 m

   Total weights on board during the experiment:

Total Ballast	2 658 t, Kg 1.95 m	Tanks full.
Bunkers	9 t, Kg 13.85 m	Free surface moment 847 tm
Fresh Water	76 t, Kg 15.82 m	Free surface moment 756 tm
Four inclining weights each	90 t, Kg 18.89 m	

   At the time of the experiment the boilers are empty. They would usually contain a total of 28 t of water, Kg 9.36 m, with a free surface moment of 305 tm.

   Both lifeboats, each weighting 12 t are still ashore and will be fitted on the vessel at a Kg of 21.20 m at a later date.

   The plumbline has an effective vertical length of 17700 mm. The inclining weights are shifted transversely 28.00 m on each occasion and the mean horizontal deflection of the plumbline is 176 mm.

   (a) Calculate the vessel's Lightship KG. (30)

   (b) Describe, giving reasons, a suitable mooring arrangement so as to improve the accuracy and reliability of the incline test results. (6)

3. A box shaped vessel floating upright on an even keel in salt water has the following particulars:

Length 140.00 m Breadth 26.00 m Draught 8.400 m KG 9.10 m

The vessel has two longitudinal bulkheads each 6.00 m from the side of the vessel.

Calculate the angle of heel if a midship compartment 24.00 m long is bilged. (36)

4. With reference to the IMO International Grain Code:

(a) describe how the horizontal shift in the ship's centre of gravity (GG_H) due to an assumed shift of grain is accounted for when determining compliance with the Code; (16)

(b) describe how the loss in GM (GG_V) due to an assumed shift of grain is accounted for when determining compliance with the Code with respect of EACH of the following:

(i) full holds; (9)

(ii) part full holds. (9)

(c) outline SIX measures which may be taken to minimise grain heeling moments. (12)

5. (a) Describe ONE change in ship condition (other than bilging) that may affect the position of EACH of the following:

(i) Longitudinal Centre of Gravity (LCG); (4)

(ii) Longitudinal Centre of Buoyancy (LCB); (4)

(iii) Longitudinal Centre of Flotation (LCF). (4)

(b) Explain why the trim of a vessel may change with a change in dock water density. (8)

(c) Explain why the MCTC extracted from a ship's hydrostatic tables for a given draught needs to be corrected for dock water density. (6)

(d) Define the Angle of Flooding and explain its relevance to ship stability, describing how its value is obtained. (8)

(e) The magnitude of longitudinal metacentric height (GM_L) is usually much greater than that of the transverse metacentric height (GM_T).

Explain why this is so for a box shaped vessel. (8)

(This Worksheet must be returned with your answer book)

TRIM & STABILITY WORKSHEET

CONDITION:

Compartment	Capacity m^3	Stowage Factor m^3/t	Weight t	KG m	Vertical Moment m	Free Surface Moment tm	LCG foap m	Longitudinal Moment tm
Crew & effects			6	25.00			32.00	
Provisions			19	19.00			32.00	
Fresh water			80	30.50		75	31.00	
HFO			250	0.50		936	57.02	
Diesel			95	0.80		230	35.60	
Water ballast			0					
No. 1 Hold	1 770	0.86		4.55			114.48	
No. 2 Hold	4 480	0.86		4.20			89.97	
No. 3 Hold	1 463	0.86		3.95			68.91	
No. 4 Hold	2 386	0.86		4.15			51.77	
No. 5 Hold	1 931	0.86		7.65			17.26	
Total Free Surface Moments:								
Deadweight:								
Lightship:			3 831	8.211			61.67	
DISPLACEMENT:								

HYDROSTATICS

TMD:		MCTC:		LCB:		LCF:	

Trim calculation:

KM_T:	
KG:	
GM:	

FINAL DRAUGHTS: **Fwd:** **Aft:**

Candidate's Name .....

Examination Centre .....

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032-74 – STABILITY AND STRUCTURE

FRIDAY, 01 DECEMBER 2023

0915 - 1145 hrs

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Candidate's examination workbook Stability Data Booklet A Stability Formulae Datasheet (Version: September 2020)

Examination Paper Inserts

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Maritime & Coastguard Agency

SQA

STABILITY AND STRUCTURE

Attempt ALL questions

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1. A ship is berthed port side to in dock water (R.D. 1.013) with a 3° list to port. She has a forward draught of 5.850 m, an aft draught of 6.150 m and a KG of 8.14 m.

   A 26 t piece of project cargo is to be loaded using the ship's own derrick. It is currently on the quay, 17.50 m from the centreline and the head of the derrick when slewed during loading will be 19.30 m above the keel.

   The stow position is: tcg 7.60 m starboard Kg 5.00 m.

   Using *Stability Data Booklet A:*

   (a) calculate the maximum list experienced during the operation; (22)

   (b) calculate the size and direction of any list once the weight is stowed. (8)

   (c) Describe how the introduction of Free Surface Moments (FSM) alone would affect the list. (4)

   (d) With reference to the Maximum KG Table determine whether the vessel complies with the minimum intact stability criteria of the current Load Line Regulations in this final condition. (6)

2. A box-shaped vessel floating at an even keel in salt water has the following particulars:

   Length 102.00 m Breadth 23.00 m Draught 4.800 m

   An amidship double bottom compartment 18.00 m long, extending full breadth of vessel, is bilged. The compartment is loaded with a permeability of 0.65 and has a height of 0.90 m.

   Calculate EACH of the following:

   (a) the final draught; (16)

   (b) the change in GM. (24)

3. A vessel operating in severe winter conditions suffers from non-symmetrical ice accretion on decks and superstructure.

   (a) Sketch a fully labelled curve of statical stability showing the effects of the non-symmetrical icing. (24)

   (b) Describe the effects that the non-symmetrical icing has had on the vessel's statical and dynamic stability, providing reasons for the changes. (16)

4. (a) Explain the increase in draught due to list/heel and why this may be relevant when performing an inclining test. (10)

   (b) Explain why True Mean Draught is preferred to Arithmetic Mean Draught when extracting hydrostatic values from stability tables. (8)

   (c) Describe FIVE dangers to a vessel as a direct result of being at an angle of loll. (10)

   (d) Describe the purpose of the *Stockholm Agreement* and identify the type of vessel to which it applies. (12)

5. (a) State the general provisions of the current Load Line Regulations required for a Type 'B' ship to be awarded the same tabular freeboard as a Type 'A' ship. (24)

   (b) State the vertical, horizontal and transverse damage assumptions requirements for both Type A and B vessels of the current Load Line Regulations. (6)

   (c) Describe the general provisions of the current Load Line Regulations governing the stability in the final condition ('Condition of Equilibrium'). (10)